

REMARKS

Claims 1-3, 11-15 and 18-20 have been amended. The amendments to the claims are supported by the specification, at least at p. 11, line 28 – p. 12, line 19; p. 17, lines 15-17; and p. 65, line 7 – p. 66, line 5. Claims 4, 5, 10, 16, 17, 21 and 22 have been cancelled. No new matter has been added. Claims 1-3, 11-15 and 18-20 are pending in this application.

Information Disclosure Statement

Applicants are filing herewith a Supplemental Information Disclosure Statement (IDS) and Form PTO-1449. This statement lists the references that were cited in the IDS's filed on February 13, 2003, February 20, 2003, and March 13, 2003. Copies of the cited documents are not included, as the Office Action indicates that these IDS's are presently in the application file.

Objection to New Matter

Claim 13 was rejected under 35 U.S.C. § 132 as introducing new matter. The Office Action asserts that the recitation of both hydrophilic monomeric units and water-soluble nonionic monomeric units is not supported by the specification. Rather, the Office Action acknowledges only that the specification supports either hydrophilic monomeric units or water-soluble nonionic monomeric units.

The objection to claim 13 is respectfully traversed. At p. 14, lines 19-22, the specification states:

The ion-specific cationic polymers of the present invention comprise 1) a cationic monomer, 2) at least one water insoluble, hydrophobic monomer, and optionally, 3) a hydrophilic **and/or** water-soluble nonionic monomer. [emphasis added]

In addition, at p. 15, lines 9-14, the specification lists substances that can be used as a "hydrophilic **and/or** water-soluble nonionic monomer" (emphasis added). These

statements in the application as filed explicitly disclose that ion-specific cationic polymers can comprise cationic monomeric units, water insoluble, hydrophobic monomeric units, hydrophilic monomeric units and water-soluble nonionic monomeric units. Accordingly, claim 13 does not introduce new matter into the application, and Applicants request that this objection be withdrawn.

Rejections under 35 U.S.C. § 112

Rejection under 35 U.S.C. § 112, 1st paragraph

Claim 13 was rejected under 35 U.S.C. § 112, 1st paragraph as containing subject matter not described adequately in the specification. The Office Action asserts that the recitation of both hydrophilic monomeric units and water-soluble nonionic monomeric units is not described in the specification. The rejection of claim 13 is respectfully traversed. As noted above, the specification explicitly discloses that ion-specific cationic polymers can comprise cationic monomeric units, water insoluble, hydrophobic monomeric units, hydrophilic monomeric units and water-soluble nonionic monomeric units, at least at p. 14, lines 19-22 and p. 15, lines 9-14. Accordingly, claim 13 is adequately described in the specification, and Applicants request that this objection be withdrawn.

Rejections under 35 U.S.C. § 112, 2nd paragraph

The rejection of claims 4, 5 and 22 under 35 U.S.C. § 112, 2nd paragraph has been obviated by appropriate amendment. Claims 4, 5 and 22, and claims 16 and 17 which depend from claims 4 and 5 respectively, have been cancelled without prejudice to their pursuit in a Continuation or Divisional Application.

Claims 11 and 13-17 were rejected under 35 U.S.C. § 112, 2nd paragraph as indefinite. The Office Action asserts that the term "hydrophilic" is a relative term, and that the metes and bounds of this term cannot be determined.

The rejection of claims 11 and 13-15 is respectfully traversed. The term "hydrophilic" is defined in *Merriam-Webster's Collegiate Dictionary, 10th Ed.* as "of, relating to, or having a strong affinity for water." Typically, as in the present application, this term is presented in combination and contrast with the term "hydrophobic," defined as "lacking affinity for water." Thus, polymers prepared from hydrophobic monomers will tend not to absorb water or to allow water to spread on the polymer surface. Polymers prepared from hydrophilic monomers will tend to allow water to spread on the polymer surface and will tend to absorb, and possibly dissolve in, water. In the present application, the combination and distribution of different monomeric units, including units derived from hydrophobic monomers and hydrophilic monomers, throughout a cationic polymer can provide for surprising and unexpected solubility properties of the polymer. Beyond the definitions understood by those skilled in the art, the term hydrophilic is further clarified and defined in the specification by the provision of examples. Page 15, lines 9-18 lists a number of hydrophilic and/or water-soluble monomers that can be present in the polymerization mixture. These exemplary monomers are contrasted with the hydrophobic monomers listed in the preceding paragraph (p. 15, lines 3-8).

Thus, the term "hydrophilic" as recited in the claims is a widely used term in the art and is as precise as the subject matter permits. As noted in MPEP § 2173.05(a),

The requirements for clarity and precision must be balanced with the limitations of the language and the science. If the claims, read in light of the specification, reasonably apprise those skilled in the art both of the utilization and scope of the invention, and if the language is no more precise as the subject matter permits, the statute (35 U.S.C. § 112, second paragraph) demands no more ...

If the proposed language is not considered as precise as the subject matter permits, the examiner should provide reasons to support the conclusion of indefiniteness ...

[emphasis and ellipses added]

If the Office wishes to assert that the term "hydrophilic" is not as precise as the subject matter permits, Applicants request that reasons for a conclusion of indefiniteness be stated on the record, pursuant to MPEP § 2173.05(a). The only reason for

indefiniteness of this term of art set forth in the Office Action is that the term is "a relative term." However, this reasoning alone is not sufficient to support a rejection based on indefiniteness. As further noted in MPEP § 2173.05(b),

The fact that claim language, including terms of degree, may not be precise, does not automatically render the claim indefinite under 35 U.S.C. § 112, second paragraph ... Acceptability of the claim language depends on whether one of ordinary skill in the art would understand what is claimed, in light of the specification.

[citation omitted]

Applicants respectfully submit that the term hydrophilic is a term well understood by those skilled in the art and does not create indefiniteness regarding the metes and bounds of the claim. Accordingly, Applicants request that this rejection be withdrawn.

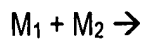
Rejections under 35 U.S.C. § 102 / 103

The pending claims were rejected under 35 U.S.C. § 102(b) or § 103(a) over Larson et al. (U.S. Pat. No. 5,459,007; referred to herein as Larson '007) or Larson et al. (U.S. Pat. No. 5,441,841; referred to herein as Larson '841). The Office Action asserts that both Larson '007 and Larson '841 disclose a mixture of thermoplastic resin particles and a quaternary ammonium copolymer. The Office Action correlates the quaternary ammonium copolymers with Applicants' cationic polymer and asserts that the copolymers disclosed in the references must have the solubility and dispersibility properties recited in the claims.

The rejection of the claims over Larson '007 and Larson '841 has been obviated by appropriate amendment. As amended, independent claims 1-3 and 18-20 each recite that the cationic polymer is formed from a mixture comprising cationic monomers and non-cationic monomers, or comprising cationic monomers and water-insoluble, hydrophobic monomers. The polymerization methods described in the specification result in a distribution throughout the polymer chain of monomer units derived from the monomers in the polymerization mixture. Evidence for this type of copolymer structure

and its relation to the copolymerization is provided in *Principles of Polymerization*, 3rd Ed., George G. Odian, New York:John Wiley & Sons, 1991, a relevant portion of which is attached as Appendix A. This reference states:

... chain polymerizations can be carried out with **mixtures of two monomers** to form polymeric products with two different structures in the polymer chain. This type of chain polymerization process in which two monomers are **simultaneously polymerized** is termed a *copolymerization* and the product is a *copolymer*. ... The process can be depicted as



... The simultaneous chain polymerization of different monomers can also be carried out with **mixtures of three or more monomers**.

[Odian, p. 452, bold emphasis and ellipses added]

In contrast, the copolymers disclosed in Larson '007 and Larson '841 are described as block copolymers. See, for example, col. 7, lines 3-19 and line 43 – col. 8, line 7 in Larson '007; and col. 6, line 30 – col. 7, line 43 in Larson '841. These block copolymers contain two discrete segments, each segment containing only one type of monomer unit. The group transfer polymerization method disclosed in Larson '007 and Larson '841 involves the polymerization of one type of monomer to form the first copolymer segment, followed by the polymerization of the second type of monomer to form the second copolymer segment. See, for example, col. 20, line 17 – col. 21, line 37 in Larson '007; and col. 20, line 40 – col. 25, line 25 in Larson '841. This disclosure of the references is consistent with the evidence in the Odian reference cited above, which states:

Block and graft copolymers differ from the other copolymers in that there are long sequences of each monomer in the copolymer chain. A block copolymer is a linear copolymer with one or more **uninterrupted sequences of each polymeric species**,



... Graft copolymers and, to a large extent, block copolymers are **not synthesized by the simultaneous polymerization of two monomers.**

[O'dian, p. 454, bold emphasis and ellipses added]

The block copolymers of Larson '007 and Larson '841 have chemical structures that are distinct from the chemical structures of the cationic polymers recited in the claims. Thus, the block copolymers disclosed in these references will not necessarily have the solubility and dispersibility properties recited in the claims. There is no disclosure, teaching or suggestion in Larson '007 or Larson '841 that formulations containing the block copolymers exhibit solubility and dispersibility properties as claimed. Specifically, there is no disclosure, teaching or suggestion in the references of a polymer formulation that:

... is insoluble in aqueous solution containing at least about 0.5 weight percent divalent metal salt ...

and that

... is dispersible in water containing up to about 200 ppm of one or more mono or multivalent ions.
[claims 1-3 and 18-20]

Although the Office Actions have asserted that the block copolymers of Larson '007 or Larson '841 are dispersible soft or hard water, due to their use as liquid developers, no evidence has been placed on the record to show that these block copolymers are also insoluble in aqueous solution containing at least about 0.5 weight percent divalent metal salt.

The Larson '007 and Larson '841 references, alone or in combination, fail to disclose or to teach or suggest each and every element of claims 1-3, 11-15 and 18-20. Accordingly, Larson '007 and/or Larson '841 cannot anticipate or make obvious the pending claims, and Applicants respectfully request that this rejection be withdrawn.

CONCLUSION


In conclusion, all of the grounds raised in the present Office Action for rejecting the application are believed to be overcome or rendered moot based on the remarks above. Thus, it is respectfully submitted that all of the presently presented claims are in form for allowance, and such action is requested in due course. Should the Examiner feel a discussion would expedite the prosecution of this application, the Examiner is kindly invited to contact the undersigned.

Submitted herewith are the following:

- Request for Continued Examination pursuant to 37 CFR § 1.114;
- Petition for Extension of Time for two (2) months; and
- Supplemental Information Disclosure Statement and Form PTO-1449.

Respectfully submitted,

11/3/03



Jonathan P. Taylor, Ph.D.
Registration No. 48,338
Agent for Applicant

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, ILLINOIS 60610
(312) 321-4200

APPENDIX A

Principles of Polymerization, 3rd Ed., George G. Odian, New York: John Wiley & Sons, 1991, pp. 452 – 454.

CHAPTER 6

CHAIN COPOLYMERIZATION

For most step polymerizations, for example, in the synthesis of poly(hexamethylene adipamide) or poly(ethylene terephthalate), two reactants or monomers are used in the process, and the polymer obtained contains two different kinds of structures in the chain. This is not the case for chain polymerizations where only one monomer need be used to produce a polymer. However, chain polymerizations can be carried out with mixtures of two monomers to form polymeric products with two different structures in the polymer chain. This type of chain polymerization process in which two monomers are simultaneously polymerized is termed a *copolymerization* and the product is a *copolymer*. It is important to stress that the copolymer is not an alloy of two homopolymers but contains units of both monomers incorporated into each copolymer molecule. The process can be depicted as



The two monomers enter into the copolymer in overall amounts determined by their relative concentrations and reactivities. The simultaneous chain polymerization of different monomers can also be carried out with mixtures of three or more monomers. Such polymerizations are generally referred to as *multicomponent copolymerizations*; the term *terpolymerization* is specifically used for systems of three monomers.

Copolymerization is also important in step polymerization. Relatively few studies on step copolymerization have been carried out, although there are considerable commercial applications. Unlike the situation in chain copolymerization, the overall composition of the copolymer obtained in a step copolymerization is usually the same as the feed composition since step reactions must be carried out to close to 100% conversion for the synthesis of high-molecular-weight polymers. Further, most step polymerizations are equilibrium reactions and the initially formed copolymer com-

position is rapidly changed by equilibrium chain copolymerization. The main point is in Sec. 2-13.

6-1 GENERAL CONSIDERATIONS

6-1a Importance of Chain Copolymerization

Chain copolymerization is important because of the reactivities of monomers. In chain polymerization comes from the fact that in copolymerization reactions is essential to consider the effect of the structure on reactivity. Copolymerization from a different viewpoint. It greatly increases the diversity of the polymer product with specifically defined properties. The range of monomer is relatively limited as to the number of monomers. The term *homopolymerization* is often used to describe the polymerization of a single monomer from the copolymerization process.

Copolymerization allows the synthesis of a wide variety of products by variations in the nature of the monomers in the copolymer product. A prime example of this process is the case of polystyrene. Many different products are produced annually in the form of styrene homopolymer. Polystyrene has high strength and low solvent resistance (Sec. 3-12). The addition of other monomers increase the usefulness of polystyrene as plastics but also increase the cost. The addition of acrylonitrile leads to increased impact strength. The addition of 1,3-butadiene leads to increased flexibility. Other technological applications of copolymerization are discussed in Sec. 5-2h and 6-8.

6-1b Types of Copolymers

The copolymer described by Eq. (6-1) is a random copolymer. The distribution of the two monomer units in the copolymer is described by statistical law, for example, Bernoulli or Markov. Copolymers formed via Bernoulli or Markov are distributed randomly and are referred to as *random copolymers*. The distinction between random and block copolymers by IUPAC [Ring et al., 1985], has given rise to the term *random copolymerization*. Many references use the term *random copolymerization* to describe the process involved in synthesizing the copolymer. The term *random copolymerization* involves the synthesis of copolymer structures—*alternating*, *block*, and *gradient*—in which the monomer units in equimolar amount.



position is rapidly changed by equilibration. This chapter is concerned entirely with chain copolymerization. The main features of step copolymerization have been covered in Sec. 2-13.

6-1 GENERAL CONSIDERATIONS

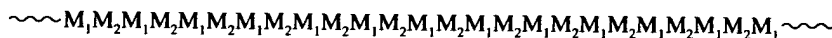
6-1a Importance of Chain Copolymerization

Chain copolymerization is important from several considerations. Much of our knowledge of the reactivities of monomers, free radicals, carbocations, and carbanions in chain polymerization comes from copolymerization studies. The behavior of monomers in copolymerization reactions is especially useful for studying the effect of chemical structure on reactivity. Copolymerization is also very important from the technological viewpoint. It greatly increases the ability of the polymer scientist to tailor-make a polymer product with specifically desired properties. Polymerization of a single monomer is relatively limited as to the number of different products that are possible. The term *homopolymerization* is often used to distinguish the polymerization of a single monomer from the copolymerization process.

Copolymerization allows the synthesis of an almost unlimited number of different products by variations in the nature and relative amounts of the two monomer units in the copolymer product. A prime example of the versatility of the copolymerization process is the case of polystyrene. More than 8 billion pounds per year of polystyrene products are produced annually in the United States. Only about one-third of the total is styrene homopolymer. Polystyrene is a brittle plastic with low impact strength and low solvent resistance (Sec. 3-13b-2). Copolymerization as well as blending greatly increase the usefulness of polystyrene. Styrene copolymers and blends of copolymers are useful not only as plastics but also as elastomers. Thus copolymerization of styrene with acrylonitrile leads to increased impact and solvent resistance while copolymerization with 1,3-butadiene leads to elastomeric properties. Combinations of styrene, acrylonitrile, and 1,3-butadiene improve all three properties simultaneously. This and other technological applications of copolymerization are discussed further in Secs. 5-2h and 6-8.

6-1b Types of Copolymers

The copolymer described by Eq. 6-1, referred to as a *statistical copolymer*, has a distribution of the two monomer units along the copolymer chain that follows some statistical law, for example, Bernoullian (zero-order Markov) or first- or second-order Markov. Copolymers formed via Bernoullian processes have the two monomer units distributed randomly and are referred to as *random copolymers*. The reader is cautioned that the distinction between the terms *statistical* and *random*, recommended by IUPAC [Ring et al., 1985], has generally not been followed in the literature. Most references use the term *random copolymer* independent of the type of statistical process involved in synthesizing the copolymer. There are three other types of copolymer structures—*alternating*, *block*, and *graft*. The alternating copolymer contains the two monomer units in equimolar amounts in a regular alternating distribution,



I

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synthesis of poly(hexamethylene actants or monomers are used in o different kinds of structures in ations where only one monomer in polymerizations can be carried neric products with two different polymerization process in which rmed a *copolymerization* and the t the copolymer is not an alloy of omers incorporated into each co-



all amounts determined by their ltaneous chain polymerization of tures of three or more monomers. ulticomponent copolymerizations; ystems of three monomers. merization. Relatively few studies although there are considerable ain copolymerization, the overall polymerization is usually the same be carried out to close to 100% ght polymers. Further, most step initially formed copolymer com-

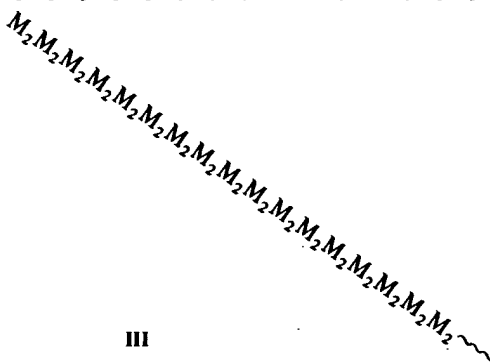
Alternating, statistical, and random copolymers are named by following the prefix "poly" with the names of the two repeating units. The specific type of copolymer is noted by inserting *-alt-*, *-stat-*, or *-ran-* in between the names of the two repeating units with *-co-* used when the type of copolymer is not specified, for example, poly(styrene-*alt*-acrylonitrile), poly(styrene-*stat*-acrylonitrile), poly(styrene-*ran*-acrylonitrile), and poly(styrene-*co*-acrylonitrile).

Block and graft copolymers differ from the other copolymers in that there are long sequences of each monomer in the copolymer chain. A block copolymer is a linear copolymer with one or more long uninterrupted sequences of each polymeric species,



II

while a graft copolymer is a branched copolymer with a backbone of one monomer to which are attached one or more side chains of another monomer,



III

This chapter is primarily concerned with the simultaneous polymerization of two monomers to produce statistical and alternating copolymers. Graft copolymers and, to a large extent, block copolymers are not synthesized by the simultaneous polymerization of two monomers. These are generally obtained by other types of reactions. Block copolymers are considered in Chaps. 5 and 9, graft copolymers in Chap. 9. The nomenclature for block and graft copolymers is described in Sec. 2-13a.

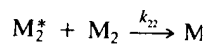
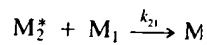
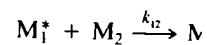
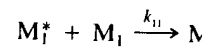
6-2 COPOLYMER COMPOSITION

6-2a Copolymerization Equation; Monomer Reactivity Ratios

The composition of a copolymer is usually different from the composition of the comonomer feed from which it is produced. In other words, different monomers have differing tendencies to undergo copolymerization. It was observed early that the relative copolymerization tendencies of monomers usually bore little resemblance to their relative rates of homopolymerization [Staudinger and Schneiders, 1939]. Some monomers are more reactive in copolymerization than indicated by their rates of homopolymerization; other monomers are less reactive. Further, and most dramati-

cally, a few monomers have a tendency to undergo facile copolymerization.

The composition of the homopolymer and the chemical reactivity of the monomer unit preceding the last monomer in the copolymer chain, or carbocation, are studied and is more in case without specific or cationic species. (These can be represented as a carbocation ion, or a particular case. If it is associated only on the monomer unit), four propagation reactions can add either to a propa-



where k_{11} is the rate constant for the propagation of a reactive center by a monomer of the same type (6-2 and 6-5) is often referred to as *cross-propagation* and is assumed to be irreversible.

Monomer M_1 disappears by Reactions 6-3 and 6-4, which are synonymous with the

$$-\frac{d[M_1]}{dt} = k_{11}[M_1^*]$$

$$-\frac{d[M_2]}{dt} = k_{12}[M_1^*]$$

PRINCIPLES OF POLYMERIZATION

Third Edition

GEORGE ODIAN
The College of Staten Island
The City University of New York
Staten Island, New York



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PREFACE

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This book describes the physical and chemical properties of polymer molecules as they are synthesized. It is intended for the reader who is interested in the characteristics of polymer molecules (Chap. 1) and then in the mechanisms of polymerization reactions—homopolymers (2–5, 7). Polymerization reactions are discussed in terms of their thermodynamic features, their kinetic features, and the physical properties of the polymer structures, and the physical properties of the polymer structures. Polymer chemistry has advanced rapidly in the last few years, and a variety of different types of polymerization reactions are now being used. Emphasis is placed throughout the book on the physical and chemical features that are important in controlling polymerization reactions. The reader will gain an appreciation of the physical and chemical features of polymerization reactions and that is available to the synthesis of polymers.

The versatility of polymerization reactions is discussed in terms of the types of polymerization reactions that can be polymerized but are not polymerized by stereospecific polymerization. The types of polymerization reactions are discussed in the appropriate chapters. The types of polymerization reactions are discussed in terms of their physical and chemical features by the appropriate choice of polymerization reactions (9), the reactions of polymers that are discussed in terms of their physical and chemical structures and the use of polymerization reactions. The literature has been covered in the appropriate chapters.

This book is intended for the experienced polymer chemist. Each chapter is intended for the polymer chemist. Each chapter is intended for the polymer chemist.